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RTNEPH
AFCCC Climatic Database
Users Handbook No. 1

by
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Pat Giese

September 1986
(Revised November 1996)

Air Force Combat Climatology Center
Operating Location A
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REVIEW AND APPROVAL STATEMENT

USAFETAC/UH—86/001 (Revised), *RTNEPH AFCCC Climatic Database Users Handbook No. 1, September 1986, (November 1996)* has been reviewed and is approved for public release. There is no objection to unlimited distribution of this document to the public at large, or by the Defense Technical Information Center (DTIC) to the National Technical Information Service. (NTIS).

FOR THE COMMANDER

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PREFACE

Air Force Global Weather Center (AFGWC) produces a global cloud analysis called Real-Time Nephanalysis (RTNEPH). The purpose of USAFETAC—86/001 (Revised November 1996), *RTNEPH AFCCC Climatic Database Users Handbook No. 1*, is to provide users with information on the history, production, and content of the RTNEPH climatic database.

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Chapter 1

INTRODUCTION

1.1 Purpose of the Handbook. This handbook provides users of the Real-Time Nephanalysis (RTNEPH) Climatic Database with information on its history, production, and content. The handbook will also explain the RTNEPH analysis, discuss RTNEPH processing and quality control, and describe the Low/Middle/High Type/Amount (LMHT/A) Database (a derivative of RTNEPH).

1.2 RTNEPH History and Background. Aug. 1, 1983, the Air Force Global Weather Center (AFGWC), at Offutt AFB, Neb., started production of a global cloud analysis called the RTNEPH. The new cloud analysis replaced its predecessor, the Three-dimensional Nephanalysis (3DNEPH), a detailed description of which can be found in AFGWC Technical Memorandum 78-002. A detailed description of the RTNEPH model is given in AFGWC/TN–88/001, the AFGWC Automated Real-Time Cloud Analysis Model.

AFGWC produces RTNEPH data every 3 hours, eight times a day, for operational forecasting and other customer support applications. The analyses for each day are sent to AFCCC's Operation Location A (OL-A) in Asheville, N.C., for inclusion in the USAF climatological database. OL-A started building the RTNEPH Climatic Database with the Jan. 1, 1984 data.

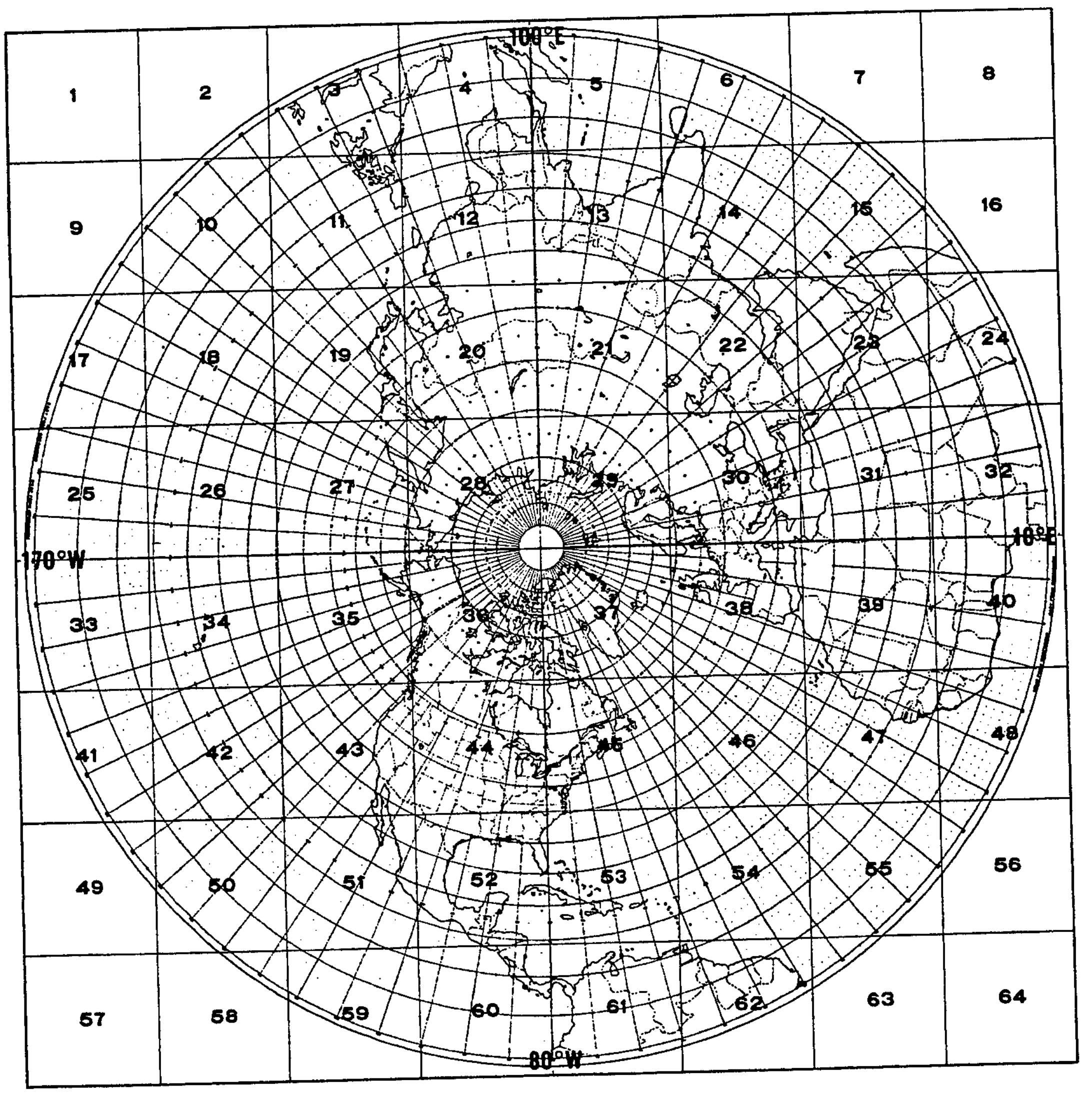
RTNEPH has several distinct advantages over the 3DNEPH. Its four floating cloud layers, for example, give it greater vertical resolution than could be provided by 3DNEPH's 15 fixed layers. Other improvements, such as better input algorithms and the use of weighting factors for age of data and conventional vice satellite data, have also greatly improved the analysis. The RTNEPH also includes visibility, present weather intensity, and information about the kind of input data used to produce the cloud analysis.

1.3 Questions and Comments. Address questions or comments on the RTNEPH Climatic Database to AFCCC, 151 Patton Ave. Room 120, Asheville, NC 28801-5002. For more information call DSN 266-3100, commercial (704) 271-4235.

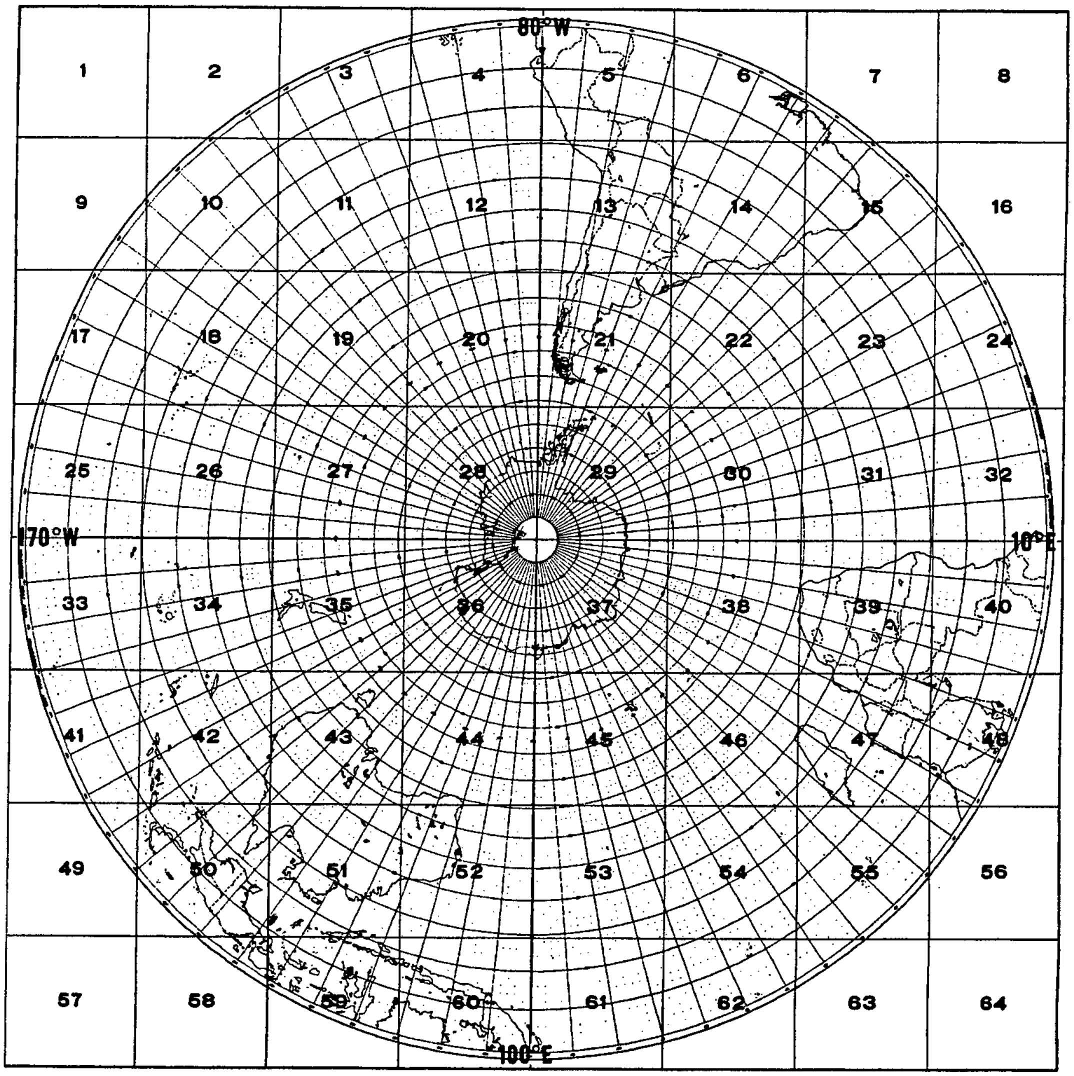
Chapter 2

DESCRIPTION OF THE REAL-TIME NEPHANALYSIS (RTNEPH)

2.1 The Eighth-Mesh Grid. The AFGWC RTNEPH model produces cloud cover data for the entire globe, using all available conventional data (surface, upper-air and aircraft) and satellite (DMSP and NOAA) data to produce an analysis every 3 hours (at 0000, 0300, 0600, 0900, 1200, 1500, 1800 and 2100 GMT). Each analysis is divided into two hemispheres: Northern and Southern. On a 1 to 3 million polar stereo-graphic projection, each hemisphere is divided into 64 numbered boxes as shown by the following illustrations. Note that 100 is added to each of the Southern Hemisphere's boxes. The four corner boxes in each hemisphere (Northern: 1, 8, 57, 64; Southern: 101, 108, 157, 164) are not used in the analysis because they are completely "off-hemisphere." Each remaining box is divided into 4,096 individual areas (64 x 64), laid out on a grid called the "1/8 mesh" or "eighth-mesh" grid. Grid points are about 25 nautical miles apart. Each grid point within a box is identified by an "I" (lateral) and a "J" (vertical) coordinate. "I-1" is the upper-left corner of each box—"I" increases to the right. "J-1" is also the upper-left corner, but "J" increases downward. Any grid point on the globe can be located by its grid box and its I and J coordinates.



Northern Hemisphere



Southern Hemisphere

With 60 boxes in each hemisphere and 4,096 grid points in each box, there are 245,760 grid points per hemisphere. But only 196,014 of the Northern Hemisphere grid points contain analysis data; in the Southern Hemisphere, only 195,805. The extra 209 grid points in the Northern Hemisphere are located exactly on the equator. All the remaining 49,000-plus grid points per hemisphere are considered to be "off-hemisphere."

More complete information on the eighth-mesh grid is available in AFGWC/TN–79/003, *Map Projections and Grid Systems for Meteorological Applications*, March 1981.

2.2 Database Elements. Each RTNEPH eighth-mesh grid point contains the following climatic database elements:

- Present weather
- Surface visibility
- Time flag for age of data
- Total cloud amount (percentage of earth in grid point area covered by clouds)
- Source flags for layer data
- Four floating cloud layers that contain:
  1-layer cloud amount
  2-layer cloud type
  3-layer cloud base
  4-layer cloud top
- Diagnostic information

2.3 Data Used. All satellite and conventional data available within each grid point area used in the analysis.

2.3.1 Satellite Data. The Defense Meteorological Satellite Program (DMSP) acquires and processes meteorological satellite data from DMSP satellites. Although there is a capability to input National Oceanographic and Atmospheric Administration (NOAA) polar orbited imagery directly in RTNEPH, it's not included routinely because of limited computer resources. Both DMSP and NOAA satellites provide infrared and visual imagery for the daylight side of the globe, and infrared imagery on the night side. The first step of the analysis process integrates all available satellite data to produce an RTNEPH satellite analysis for a grid point. Although RTNEPH can operate without satellite data, the resultant analysis would be very limited.

2.3.2 Conventional Data. In the second step, AFGWC collects all available conventional data (surface and radiosonde) from the Automated Weather Network (AWN) and integrates it into the RTNEPH conventional analysis, producing a "best report" for a given grid point. In some areas of the world (North America and Western Europe, for example), conventional data is abundant. Grid points in these regions may contain numerous surface reporting stations. For example, grid point I-13, J-51 in Box 45 of the Northern Hemisphere (latitude 40.67 north, longitude 73.99 west) offers five possible sources of surface data: Newark International Airport, N.J.; John F. Kennedy International Airport, N.Y.; and Ft.Tilden, N.Y. The AFGWC RTNEPH model, in "decision tree" fashion, selects which observations, and which elements within those observations, will be used to build a "best report" type of observations.

2.3.3 Merge Processor. The final automated step in producing an RTNEPH analysis is merging the outputs of the satellite and conventional analyses. The merge processor decides which data to use from the two inputs to produce the final product. If recent conventional and satellite data is not available for the RTNEPH analysis, AFGWC will "persist" the RTNEPH data from the previous hour's analysis.

Chapter 3

THE RTNEPH CLIMATIC DATABASE

3.1 Tape Specifications. AFCCC/OL-A's RTNEPH climatic database (Box-Time File) tape specifications are as follows:

cartridge, 37871BPI, labeled, sort =
BX-YR-M0-DA-HR Record #.
record length 14,344 bytes, unblocked,
10 tapes/month/hemisphere, 6 boxes/tape

Binary — 8-bit bytes

Eight J rows per record — (512 grid points)

Eight records per box-YR-MO-DA-HR

3.2 RTNEPH Climatic Database Format.

BINARY

									1st Point in Record								LYR 1				LYR 2				LYR 3				LYR 4				
DATA FIELD	BX	YEAR	MO	DA	HR	#	J	IND	PWX	VSBY	TF	TA	SF1	SF2	SF3	SF4	AMT	TYP	BAS	TOP	AMT	TYP	BAS	TOP	AMT	TYP	BAS	TOP	AMT	TYP	BAS	TOP	FLAGS
# BYTES	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4
BYTE LOC	1	2	3	4	5	6	7	8	9-12				13-16				17-20				21-24				25-28				29-32				33-36

512th Point in Record								LYR 1				LYR 2				LYR 3				LYR 4				
PWX	VSBY	TF	TA	SF1	SF2	SF3	SF4	AMT	TYP	BAS	TOP	AMT	TYP	BAS	TOP	AMT	TYP	BAS	TOP	AMT	TYP	BAS	TOP	FLAGS
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4
14317																								14344

NOTE: THE ELEMENTS FROM BYTE LOCATIONS 9-36 ARE REPEATED 512 TIMES.

DATA FIELD	BYTE LOCATION	CODE DEFINITION
BX	1	Box (2-7, 9-56, 58-63, 102-107, 109-156, 158-163)
YEAR	2	Year
MO	3	Month
DA	4	Day
HR	5	Hour
#	6	Record # (1-8 of box in byte 1)
j	7	J-coordinate (1, 9, 17, 25, 33, 41, 49, 57)
IND	8	Indicator: OL-A did/did not persist record 1 = Persisted by OL-A 0 = Not persisted by OL-A (if record was missing or deleted by quality control procedures)
PWX	9	* Present Weather (00-99, 255; WMO Code 4677)
VSBY	10	* Visibility (00-50, 56-99, 255; WMO Code 4377)
TF	11	Time flag (00-255, see 3.2.1)
TA	12	Total cloud amount (0-100 percent)
SF1	13	Data source flags-Layer 1 (see 3.2.2)
SF2	14	Data source flags-Layer 2 (see 3.2.2)
SF3	15	Data source flags-Layer 3 (see 3.2.2)
SF4	16	Data source flags-Layer 4 (see 3.2.2)
AMT	17	Layer 1 cloud amount (0-103, see 3.2.3)
TYP	18	Layer 1 cloud type (0-10, 25, see 3.2.4)
BAS	19	Layer 1 cloud base (0-255, see 3.2.5)
TOP	20	Layer 1 cloud top (0-255, see 3.2.5)

Note: Elements from bytes 17-20 are repeated for layer 2, layer 3 and layer 4.

FLAGS	33-36	Diagnostic flags (see 3.2.6)

DATA FOR GRID POINTS 2-512; 37-14,344 Same as for grid point 1

28 bytes x 512 points = 14,336 bytes

* Prior to June 23, 1986, at 2100Z, missing/not reported present weather and visibility data is indicated by code zero; after that data/time, Code 255 is used (see 4.4).

3.2.1 Time Flag for the Grid Point. This reflects the time of the newest data at the grid point.

CODE VALUE	DEFINITION
0-229	Indicates age of data used in RTNEPH analysis (in hours).
230	Indicates that data used in RTNEPH analysis is more than 229 hours old.
231-254	Indicates that data used in the analysis is for a data time after analysis time (code value - 230).
255	Indicates that data used in RTNEPH analysis are more than 24 hours after analysis time.

3.2.2 Source Flags for Cloud Layer Data.

BIT	DEFINITION
1	Low cloud type persisted
2	Layer cloud base estimated
3	Layer cloud top estimated
4	Best report from radiosonde data
5	Not used
6	Best report from surface data
7	Visual satellite data used as input
8	IR satellite data used as input

Note: If the bit is set on, the source condition exited.

3.2.3 Layer CloudAmount. Layer cloud amount code range is 0-103, with the layer cloud amount rounded up to the next highest 5 percent. Additional values added to the layer cloud amount indicate the following:

An added one indicates a thin cloud layer.

An added two indicates the cloud layer was derived from merging two cloud decks.

An added three indicates the combination of the one and two.

3.2.4. Cloud Types.

CODE VALUE	CLOUD TYPE
0	Clear
1	Cumulonimbus
2	Stratus
3	Stratocumulus
4	Cumulus
5	Altostratus
6	Nimbostratus
7	Altocumulus
8	Cirrostratus
9	Cirrocumulus
10	Cirrus
25	Unknown

Note: If all four RTNEPH layers contain clouds, and a ground base layer of fog is located beneath the lowest reported cloud deck, the RTNEPH will indicate the fog by adding 10 to the cloud type code for layer 4 (the lowest layers contain clouds and a ground base layer of fog is located beneath the lowest reported cloud deck and the codes for the other cloud layers are unchanged.

3.2.5 Cloud Heights (Bases and Tops)

CODE VALUES	DEFINITIONS
0-200	30-meter increments for 0-6,000 meters MSL.
201-253	300-meter increments for 6,300-21,900 meters MSL, MSL height = (code - 200) x 300 + 6,000.
254	Greater than 21,900 meters.
255	Height not available.

3.2.6 Diagnostic Flags.

BYTE	BIT	DEFINITION
1	1	Not received (bogus flag).
	2	Best report flag-a conventional report was included in this point.
	3	Spread data-data from a best report was spread to this point.
	4	Visual satellite data was included in this analysis.
	5	IR satellite data was included in this analysis.
	6	Low-level cloud has been persisted past normal data cutoff time.
	7	Identifies that although the visual satellite observed cloudy, the point is marked clear for lack of other supporting data.
	8	Fog/haze superseded by other weather elements in present weather.
2	1-3	Bits indicate the age of the oldest conventional data used in this report. This hour indicator will be used in situations when a conventional low-level cloud report was persisted while new satellite data was used as input for the analysis.
	4-8	Not used.
3	1	Not used.
	2	The "best report" contained radiosonde data.
	3	Not used.
	4	The "best report" contained surface data.
	5	Ice-water point was iced over.
	6	Snow--snow flag was set.
	7	Tropics--point is in the tropics.
	8	IR daylight quarter orbit (q.o.)-this IR q.o. was in daylight.
4	1	IR sunside quarter orbit-this point was on the sunward side of the IR q.o.
	2	Visual daylight quarter orbit-this visual q.o. was in daylight.
	3	Visual sunside quarter orbit-the visual data was on the sunward side of the visual q.o.
	4	Sunglint-visual data for this point fell in the sunglint cone.
	5-6	IR satellite ID the IR satellite ID minus 1. This is an internal ID (1-4) used to select tuning parameters at AFGWC.
	7-8	Visual satellite ID the visual satellite ID minus 1.

Chapter 4

OL-A DATA PROCESSING AND QUALITY CONTROL

4.1 Steps in RTNEPH Data Processing at OL-A:

- Check readability-inventory synoptic data.
- Quality control data.
- Build persist file and RTNEPH daily synoptic data file.
- Process 1 month of RTNEPH box-time data.
- Build hemispheric file.
- Build persist file and monthly LMHT/A hemispheric data file.
- Process monthly histogram data from LMHT/A hemispheric data file.

4.2 Quality Control at AFGWC. RTNEPH quality control at AFGWC consists of manual interface with data via a "pre-bogus" map generated twice a day. Meteorologists look for problem areas on these maps, correcting problems manually by "bogusing," and returning the corrected areas to the system. Bogusing may include any one or all the elements produced by the RTNEPH system. RTNEPH analysis data for a particular point is reviewed up to four times a day. Problem areas that were bogues by AFGWC forecasters are persisted for a minimum of 4 hours (a turnable factor) and may persist for up to 12 hours if there is no new data for the point. A post-bogus map is then generated and reviewed by analysts to verify modifications. If the bogus is verified, the workfile is cleared to allow room for future bogusing data. If the bogus is not verified, the unmodified fields are restored and a decision is made as to whether or not to reaccomplish the bogus. Any questionable data (due to satellite problems, etc.) are classified as either "unusable" or "usable with consideration," according to box-day-hour.

4.3 Quality Control at OL-A. RTNEPH quality control at OL-A consists of a series of automated gross quality control checks. These "gross" checks ensure that the data contains no obvious errors. If a grid point is in error, all the elements for that grid point are set equal to missing (i.e., code 255, all bits turned on). From January 1984 to January 1988, OL-A received (from AFGWC) a list of box-day-hours that were "unusable" or "usable with consideration." Those box-day-hours listed as "unusable" were deleted from the database, and the deleted records are filled with data from the previous synoptic hour. Those deemed "usable with consideration" are documented on AFGWC Form 12, Synoptic RTNEPH QC Log, in our files, and remain in the climatic database.

4.3.1 RTNEPH Gross Quality Control Algorithms.

ID Field Checks:

1.) Limits for Fields:

Box:	NH = 2-7, 9-56, 58-63
	SH = 102-107, 109-156, 158-163
Year:	Numeric
Month:	1-12
Day:	1-31
Hour:	00,03, 06, 09, 12, 15, 18, 21
Record #	1-8
J-Coord	1-9, 17, 25, 33, 41, 49, 57

2.) Records in sequence-check box-year-month-day-hour-record # sequence.

3.) Record # and J-coordinate in agreement-(J-coord = (rec# x 8) - 7).

4.) Missing records.

5.) Missing hours.

4.3.2 Data Field Checks:

1.) All bits turned on (1's) for off-globe points.

2.) Valid values of present weather: 00-99, 255.

3.) Valid values of visibility: 00-50, 56-99, 255.

4.) Valid values of total cloud amount: 00-100.

5.) Valid values of layer cloud amount: 0-1-3, except 1,2,3 and values that are multiples of (5 -1).

6.) Valid values of layer cloud type: 00-10, 25 - if all

four layers contain cloud data, then limits for layer four are 00-20, 25.

7.) If present weather greater than 49 and less 100, total cloud amount must not equal 0.

8.) If data is persisted more than 24 hours, present hour's data must be exactly the same as the previous hour's.

9.) No individual cloud amount can be greater than total cloud amount +7. (i.e., for one cloud layer, total cloud amount might be 26 percent; layer cloud amount would then be reported as 30 and if that cloud deck is thin and merged (see Paragraph 3.2.3), layer cloud amount could be reported as 33 while total cloud amount would be reported as 26.

10.) If any layered data element except base height is equal to zero, then all elements for that layer must also equal zero.

11.) If (10) is true, then all layers following must also equal zero.

12.) Unused bits of diagnostic flag bytes are required to be set "off."

13.) The top of a cloud layer must not be less than the base of the same layer.

14.) Layer cloud base is converted to height AGL, then checked to see if each cloud type is in the right category (low, middle, high). The terrain disc file is used to convert MSL code to AGL. Following are cloud types and their cloud base limits:

Types	Base Heights (meters-AGL)
1,2, 3, 4, 11, 12, 13, 14	0-1, 980
5, 6, 7, 15, 16, 17	1,981-5,028
8, 9, 10, 18, 19, 20	GE 5,029

15.) Valid values of cloud top: 0-254.

16.) Valid values of cloud base: 0-254.

17.) Sum of the layer cloud amounts is not less than the total cloud amount.

18.) Each succeeding layer's cloud base is less than immediately preceding layer cloud base (i.e. layer 2 cloud base less than layer 1 cloud base).

Note: If any of the above checks are failed (except 1 and 12, all elements for the grid point, except source flag, are changed to missing (all bits turned on).

4.4 Documented Problems. The RTNEPH has several documented problems resulting either from processing errors or from weaknesses in the RTNEPH model itself. In the future, some of these will be corrected as improvements are made to the model and to the weather satellite's observing capabilities.

Coastline Misinterpretation. RTNEPH can over-interpret clouds along the southwest Asian coastline. The cause appears to lie in the temperature gradients over the area.

Missing Present Weather and Visibility Coding. Prior to June 23, 1986, at 2100Z, code "0" (zero) was used for missing/not reported present weather and/or visibilities. After June 23, 1996 at 2100Z, the code for "missing" was changed to 255 (all bits "on").

Cloud Interpretation Deficiencies. The satellite sometimes has difficulty in detecting thin cirrus clouds. It also provides poor interpretation of stratus clouds in the absence of conventional data. In the snow- and ice-covered regions around the poles, satellites sometimes have trouble making the distinction between low clouds and snow or ice fields; the result is under-reporting of low clouds.

Missing SH RTNEPH Data. All December 1984 Southern Hemisphere (SH) RTNEPH data, boxes 102-112 and 153-163 were set to "missing" for all elements.

Degraded RTNEPH Data. The RTNEPH data from Dec. 6, 1988, at 0600Z through Dec. 7, 1988, at 2100Z was degraded. Total cloud amounts were good, but there were problems with individual layers.

Unusable RTNEPH Data. RTNEPH data from Jan. 2, 1990, at 0200Z through Jan. 4, 1990, at 1200Z were unusable due to software problems during production.

Persisted SH RTNEPH Data. SH boxes 102 to 105 for all eight synoptic hours for July 7, 1985, were persisted.

Missing Data. Box 45 contains no conventional data from Dec. 5, 1988, at 0000Z through April 6, 1989 at 2100Z.

Incorrect Cloud Bases. In the data from January 1984 through November 1989, bases of cumulus and stratocumulus, especially for over-water points, are often reported as zero meters.

Lack of Aircraft Data. AFGWC/TN–88/001 states that aircraft reports encoded in RECCO, ICAO, and USAF aircraft report formats will be used by the RTNEPH processor. Due to decoding problems, however, no aircraft reports of any kind have been included in RTNEPH data since January 1984.

Incorrect Default Cloud Thickness. Default cloud thickness (used to model in cloud tops or bases as defined in AFGWC/TN–88/001) have not been used consistently since January 1984.

Greater than 100 percent Coverage at Same Level. When multiple cloud layers are reported at overlapping levels, the sum of the cloud amounts of the individual layers often exceed 100 percent.

Spread Data. RTNEPH points over land contain a large percentage of spread data. Points that surround a station that reports regularly contain spread data nearly all the time. In some regions, especially in CONUS, most RTNEPH reports are of spread data.

Spread Data. When the spreading technique is used in areas with few reporting stations, the result is large blocks of identical data. These blocks have sharp boundaries that often contrast sharply with adjacent RTNEPH points based on satellite data.

Persisted Data. Over-water areas near the equator often contain large percentages of persisted data.

Default Cloud Thicknesses. Cloud thicknesses used in modeling in cloud tops and bases are not stratified for latitude or seasonal variation.

Conventional vs. Satellite Data. Because of inherent differences between conventional surface and satellite observations, there are significant statistical differences in the types and amounts of cloud coverage reported by each.

Conflicting Data Elements. When surface observations and satellite data is merged, unusual combinations can result. For example, stratus, cumulus layers, or even fog can be reported beneath large thunderstorms. Visibility or present weather reported may not always agree with the amounts or types of clouds reported.

Chapter 5

THE LMHT/A DATABASE

5.1 Content. The LMHT/A (low/middle/high cloud types and amounts and total cloud amount) database consists of cloud data derived from the RTNEPH database. Low clouds are considered to be from 0 to 1,980 meters AGL, middle from 1,981 to 5,028 meters AGL, and high above 5,028 meters AGL. Cloud types are categorized as follows:

Cloud Type	LMHT/A Category	RTNEPH CODE*
Cumulonimbus	Low	1.11
Stratus	Low	2.12
Stratocumulus	Low	3.13
Cumulus	Low	4.14
Altostratus	Middle	5.15
Nimbostratus	Middle	6.16
Altocumulus	Middle	7.17
Cirrostratus	High	8.18
Cirrocumulus	High	9.19
Cirrus	High	10.20

* When all four RTNEPH layers contain clouds and there is ground-based fog, the fog will be indicated by adding 10 to the lowest layer's type. If less than four layers contain clouds, the fog becomes the lowest layer and no changes are made to the other cloud layer types.

5.2 Database Build Procedure. The LMHT/A database build procedures validate total cloud amount and RTNEPH cloud layers for each grid point to ensure that total cloud amount, layer cloud amount, layer cloud base, and layer cloud top are not missing (cloud types can be missing). If any one of these elements, except cloud type, is missing, then low, middle, and high types and amounts are set missing, as is the total cloud amount. Validated RTNEPH layers are grouped in LMHT/A categories by cloud type, and all layers within a category are combined as shown below.

LMHT/A cloud type is coded to identify each RTNEPH cloud type reported within an LMHT/A category. For example, RTNEPH cloud layer data for a grid point might consist of the following:

LYR	MIN BASE	MAX TOP	CLD TYPE	CLD AMT
1	200	215	8	65
2	100	150	5	51
3	40	80	4	35
4	10	35	3	32

Layer 1, with RTNEPH cloud type 8 (cirrostratus), is encoded as LMHT/A high category type 3; layer 2, with RTNEPH type 5 (altostratus), is encoded as LMHT/A middle category cloud type 2; layers 3 and 4, with RTNEPH cloud types 4 (cumulus) and 3 (stratocumulus), are both included in the LMHT/A low category as cloud type 6 (stratocumulus and cumulus). The following cloud code conversion tables show the various combinations of RTNEPH cloud types possible within a low, middle, or high category, along with the corresponding LMHT/A codes.

Low Clouds

LMHT/A Code	Cloud Type	RTNEPH Code
1	Stratocumulus (SC)	3
2	Stratus (ST)	2
3	Cumulus (CU)	4
4	Cumulonimbus (CB)	1
5	SC and ST	2, 3
6	SC and CU	3, 4
7	SC and CB	1, 3
8	ST and CU	2, 4
9	ST and CB	1, 2
10	CU and CB	1, 4
11	SC, ST, and CU	2, 3, 4
12	SC, ST, and CB	1, 2, 3
13	SC, CU, and CB	1, 3, 4
14	ST, CU, and CB	1, 2, 4
15	SC, ST, CU, and CB	1, 2, 3, 4
99	Cloud type missing	25
0	No cloud present	0

Middle Clouds

LMHT/A Code	Cloud Type	RTNEPH Code
1	Altocumulus (AC)	7
2	Altostratus (AS)	5
3	Nimbostratus (NS)	6
4	AC and AS	5, 7
5	AC and NS	6, 7
6	AS and NS	5, 6
7	AC, AS, and NS	5, 6, 7
99	Cloud type missing	25
0	No cloud present	0

High Clouds

LMHT/A Code	Cloud Type	RTNEPH Code
1	Cirrus (CI)	10
2	Cirrostratus (CC)	9
3	Cirrostratus (CS)	8
4	CI and CC	9, 10
5	CI and CS	8, 10
6	CC and CS	8, 9
7	CI, CC, and CS	8, 9, 10
99	Cloud type missing	25
0	No cloud present	0

An LMHT/A category (low, middle, and high) amount is derived by combining all RTNEPH layer amounts within each category.

When all RTNEPH layers are within one category, the amount is taken directly from the RTNEPH total cloud amount.

When one RTNEPH layer is in an LMHT/A category, as in the middle and high categories of the example given earlier, the LMHT/A category amount is taken directly from the RTNEPH layer amount and adjusted down to the nearest 5 percent.

When multiple (but not all) RTNEPH layers constitute an LMHT/A category, as in the low category of the example, the RTNEPH layer amounts are combined using the following equation:

Sum layer = layer a + [1 - (layer a x .01)] x layer b x .75, where layer a is greater than or equal to layer and units are in percent.

The above algorithm is applied first to the two RTNEPH layers with the highest bases. When three layers are reported, the summed amount of the first two layers and the third RTNEPH layer are then processed in a second iteration of the above equation.

If the summed amount exceeds the RTNEPH total cloud amount, RTNEPH total cloud amount is used instead. To sum the two low categories in the above example, 35 percent for layer a and 30 percent for layer b was used:

Sum layer = 35 + [1 - (35 x .01)] x 30 x .75 = 50 percent.

When the summation of all LMHT/A layer amounts is less than the RTNEPH total cloud amount, the LMHT/A layer amounts that were derived with the above equation will be increased by computing the difference between the RTNEPH total cloud amount and the summation of the LMHT/A layer amounts, then increasing each layer by a proportional amount (i.e., the ratio of the layer amount to the summation amount) or the difference.

Finally, layer cloud amounts are coded from 0-20 as shown in the cloud amount conversion table next page. The LMHT/A total cloud amount is taken directly from RTNEPH total cloud amount and converted to LMHT/A database code from the table. The sum layer of 50 percent from the example above would be converted to code 10.

Cloud Amount (percentage)	LMHT/A Code	Cloud Amount (percentage)	LMHT/A Code
0	0	51 thru 55	11
1 thru 5	1	56 thru 60	12
6 thru 10	2	61 thru 65	13
11 thru 15	3	66 thru 70	14
16 thru 20	4	71 thru 75	15
21 thru 25	5	76 thru 80	16
26 thru 30	6	81 thru 85	17
31 thru 35	7	86 thru 90	18
36 thru 40	8	91 thru 95	19
41 thru 45	9	96 thru 100	20
46 thru 50	10	Invalid	99

5.3 LMHT/A Database Format. The LMHT/A data is structured by hemisphere (hemispheric file).

5.3.1. Grid System. The hemispheric file is on the AFGWC 512 x 512 subset of the eighth-mesh reference grid for the Northern and Southern hemispheres.

5.3.2. Tape Specifications: Cartridge, 37871 BPI labeled, sort = hemis-yr-mo-da-hr, record length = 14,356 bytes, unblocked, 8-bit bytes, 3 tapes/hemis-mo. This data will be built only upon customer request. Please allow extra time for this to be accomplished when ordering.

5.3.3 Format:

	ASCII								BINARY													
									GRID POINT 1							GRID POINT 2						
DATA FIELD	HEM	G/L	YEAR	MO	DA	HR	J 512	OPEN	LCT	LCA	MCT	MCA	HCT	HCA	TCA	LCT	LCA	MCT	MCA	HCT	HCA	TCA
# BYTES	1	1	4	2	2	2	3	00000	1	1	1	1	1	1	1	1	1	1	1	1	1	1
BYTE LOC	1			8	9			20	21						27	28						34

GRID POINT 2048						
LCT	LCA	MCT	MCA	HCT	HCA	TCA
1	1	1	1	1	1	1
14350			-			14356

NOTE: THE ELEMENTS FROM BYTE LOCATIONS 21-27 ARE REPEATED 2048 TIMES.

Data Field	Byte Location	Code Definition	Format
HEM	1	N = N Hemis, S = S Hemis	ASCII
G/L	2	G = GMT, L = LST	ASCII
YEAR	3-6	1983, 1984, etc.	ASCII
MO	7-8	01-12 = JAN-DEC	ASCII
DA	9-10	01-31	ASCII
HR	11-12	00, 03, 06, ..., 21	ASCII
J 512	13-15	1, 5, 9, 13, ..., 509	ASCII
OPEN	16-20	zeroes	ASCII
Data for grid point 1:			
LCT	21	Low cloud type (00-15, 99)	BINARY
LCA	22	Low cloud amount (00-20, 99)	BINARY
MCT	23	Mid-cloud type (00-07, 99)	BINARY
MCA	24	Mid-cloud amount (00-20, 99)	BINARY
HCT	25	High cloud type (00-07, 99)	BINARY
HCA	26	High cloud amount (00-20, 99)	BINARY
TCA	27	Total cloud amount (00-20, 99)	BINARY
Data for grid points 2 - 2,048; 28 - 14,356.		Same as for grid point 1	BINARY

7 bytes x 2,048 points = 14,336 bytes

Notes: 1. Code 99 = Missing/unknown data.
2. Cloud amount codes—see cloud amount conversion table.

5.4 LMHT/A Histogram Database. The LMHT/A histogram database includes a histogram of the number of occurrences of each LMHT/A code value of month-hour.

5.4.1. Tape Specifications: Cartridge tape, 37,871 BPI, sort = hemis-mo-hr, record length = 15,796 bytes, unblocked, 8-bit bytes, 2 tapes/hemi-mo.

5.4.2 Format. The monthly histogram data may be combined, at some future date, to include up to 8 years of data. Cell ranges for low, middle, and high cloud types and amounts are given in the tables of the end of this section.

	ASCII											BINARY							
												PT 1 123 CELLS OF HISTOGRAM AT 1 BYTE PER CELL							
DATA FIELD	HEM	G/L	MO	HR	J 512	START I	IND	OPEN	YRS	OPEN	OBS CNT	LCT	LCA	MCT	MCA	HCT	HCA	TCA	PT 2-128
# BYTES	1	1	2	2	3	3	1	3	16	16	4	17	22	9	22	9	22	22	123 BYTES EACH
BYTE LOC	1			6	7			16	17		52	53						175	176 15796

NOTE: THE ELEMENTS FROM BYTE LOCATIONS 53-175 ARE REPEATED 128 TIMES.

Data Field	Byte Location	Code Definition	Format
HEM	1	N = N Hemis, S = S Hemis	ASCII
G/L	2	G = GMT, L = LST	ASCII
MO	3-4	01-12 Jan-Dec	ASCII
HR	5-6	00, 03, 06, ... 21	ASCII
J 512	7-9	001, 512	ASCII
Start I	10-12	001, 129, 257, 385	ASCII
IND	13	1 = Days with clouds of a certain category	ASCII
OPEN	14-16	Zeroes	ASCII
YRS	17-32	Actual years included in histogram 84, 85, ... Blank = Missing	ASCII
OPEN	33-48	00, 00, ...	ASCII
OBS CNT	49-52	Number of total observations	ASCII

Data for Grid Point 1:

Low cloud type (LCT) 17 types/1 byte each	53-69	0-248 maximum counts	BINARY
Low cloud amount (LCA) 22 amounts/a byte each	70-91	0-248 maximum counts	BINARY
Mid-cloud type (MCT) 9 types/1 byte each	92-100	0-248 maximum counts	BINARY
Mid-cloud amount (MCA) 22 amounts/1 byte each	101-122	0-248 maximum counts	BINARY
High cloud type (HCT) 9 types/1 byte each	123-131	0-248 maximum counts	BINARY
High cloud amount (HCA) 22 amounts/1 byte each	132-153	0-248 maximum counts	BINARY
Total cloud amount (TCA) 22 amounts/1 byte each	154-175	0-248 maximum counts	BINARY
Data for Grid Points 2-128	176-15,796	Same as for Grid Point 1	BINARY

123 bytes x 128 points = 15,744

Notes: 1. Code 99 = Missing/unknown data.
2. Cloud amount codes 00-20; see tables.

Histogram Cell Number and Code for Low Cloud

Histogram Cell No.	Code Value	Cloud Types
1	0	No low cloud
2	1	Stratocumulus (SC)
3	2	Stratus (ST)
4	3	Cumulus (CU)
5	4	Cumulonimbus (CB)
6	5	SC + ST
7	6	SC + CU
8	7	SC + CB
9	8	ST + CU
10	9	ST + CB
11	10	CU + CB
12	11	SC + ST + CU
13	12	SC + ST + CB
14	13	SC + CU + CB
15	14	ST + CU + CB
16	15	SC + ST + CU + CB
17	99	Type unknown

Histogram Cell Number and Code for Middle Cloud

Histogram Cell No.	Code Value	Cloud Types
1	0	No middle cloud
2	1	Altocumulus (AC)
3	2	Altostratus (AS)
4	3	Nimbostratus (NS)
5	4	AC + AS
6	5	AC + NS
7	6	AS + NS
8	7	AC + AS + NS
9	99	Type unknown

Histogram Cell Number and Code for High Cloud

Histogram Cell No.	Code Value	Cloud Types
1	0	No high cloud
2	1	Cirrus (CI)
3	2	Cirrocumulus (CC)
4	3	Cirrostratus (CS)
5	4	CI + CC
6	5	CI + CS
7	6	CC + CS
8	7	CI + CC + CS
9	99	Type unknown

Histogram Cell Number and Code for All Amounts

Histogram Cell No.	Code Value	Cloud Types
1	0	0
2	1	1-5
3	2	6-10
4	3	11-15
5	4	16-20
6	5	21-25
7	6	26-30
8	7	31-35
9	8	36-40
10	9	41-45
11	10	46-50
12	11	51-55
13	12	56-60
14	13	61-65
15	14	66-70
16	15	71-75
17	16	76-80
18	17	81-85
19	18	86-90
20	19	91-95
21	20	96-100
22	99	amount unknown